06/07/00 Jc845 U.S. PTO

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Jc833 U.S. PTO 09/589306 06/07/00

Date: June 7, 2000
Docket No. YO998-267X
Prior Art Unit: 2871
Prior Examiner: K. Parker

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This is a request for filing a [X] continuation [ ] divisional [ ] continuation-in-part under 37 C.F.R. **1.53(b)** of pending prior application Serial No. 09/154,019 filed on September 16, 1998 of Anthony Cyril Lowe for ENHANCED LIGHT-SCATTERING DISPLAY.

1. [ ] As last amended, the title has been changed to ______________.
2. [ ] As last amended, the name of applicant has been changed to ______________.

3. [X] Enclosed is [X] a copy of the oath or declaration as filed in the prior application or [ ] a new oath or declaration.

4. [X] The filing fee is calculated below:

CLAIMS AS FILED IN THIS APPLICATION	NUMBER FILED				NUMBER EXTRA		RATE		BASIC FEE
								=	$690.00
TOTAL CLAIMS	4	-	20	=	0	X	$18.00	=	
INDEPENDENT CLAIMS	1	-	3	=	0	X	$78.00	=	
MULTIPLE DEPENDENT CLAIMS, (IF ANY)								=	
TOTAL FILING FEE								=	$690.00

5. [X] Charge any fees which may be required, except for the Issue Fee, or credit any overpayment to Deposit Account No. 09-0468.
6. [X] Cancel in this application original Claims 1-16 of the prior application before calculating the filing fee.
7. [X] Amend the specification by inserting before the first line the sentence: - This is a [X] continuation [ ] division [ ] continuation-in-part of application Serial No. 09/154,019, filed September 16, 1998.
8. [ ] Priority of application Serial No. ______ ,filed on ________ in ________ is claimed under 35 U.S.C. 119.
9. [ ] The certified copy of the priority application has been filed in prior application Serial No. ________ filed ______________.
10. [ ] An appointment of associates is enclosed.
11. [X] Address all future communications to Dr. Daniel P. Morris, Esq., IBM Corporation, Intellectual Property Law Department, P.O. Box 218, Yorktown Heights, New York 10598.
12. [X] A preliminary amendment to this application is enclosed.
13. [ ] Enter in this application the amendment under 37 C.F.R. 1.116 which was unentered in the prior application.

IBM Corporation
Intellectual Property Law
P.O. Box 218
Yorktown Heights, NY 10598

By: Dr. Daniel P. Morris, Esq.
Reg. No. 32,053
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Express Mail Label Number:
EL627131505US
Date of Deposit: June 7, 2000

06-08-00 A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: A. C. Lowe
Serial No.:
Filed: Herewith
For: ENHANCED LIGHT-SCATTERING DISPLAY

Docket No.: YO998-267X
Group No.:
Examiner:

Assistant Commissioner for Patents
Washington, D.C. 20231

EXPRESS MAIL CERTIFICATE

Express Mail Label Number EL627131505US
Date of Deposit June 7, 2000

I hereby certify that the attached paper or fee

Request for filing a Continuation Application under 37 CFR 1.53(b)
Copy of original patent application, as filed
Copy of original drawings, as filed (5 sheets)
Copy of Declaration and Power of Attorney
Preliminary Amendment
Return Postcard

is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Jennifer A. Smith
(Name)

Jennifer A. Smith
Signature

Note: Each paper must have its own certificate and the "Express Mail" label number as a part thereof or attached thereto. When, as here, the certification is presented on a separate sheet, that sheet must (1) be signed and (2) fully identify and be securely attached to the paper or fee it accompanies. Identification should include the serial number and filing date of the application as well as the type of paper being filed, e.g. complete application, specification and drawings, responses to rejection or refusal, notice of appeal, etc. If the serial number of the application is not known, the identification should include at least the name of the inventor(s) and the title of the invention.

Note: The label number need not be placed on each page. It should, however, be placed on the first page of each separate document, such as, a new application, amendment, assignment, and transmittal letter for a fee, along with the certificate of mailing by "Express Mail". Although the label number may be on checks, such a practice is not required. In order not to deface formal drawings it is suggested that the label number be placed on the back of each formal drawing or the drawings be accompanied by a set of informal drawings on which the label number is placed.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Applicants: Date: June 7, 2000

A. C. Lowe Group Art Unit:

Serial No.: Examiner:

Filed: Herewith Docket No: YO998-267X

For: ENHANCED LIGHT-SCATTERING DISPLAY

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

IN THE CLAIMS

Cancel claims 1-16.

17. (Added) A reflective display device comprising:

a light incident side and an opposite side, the display device comprising a diffusing liquid crystalline material,

a first substrate on the light incident side and a second substrate on the opposite side enclosing the liquid crystalline material, and

reflecting means between said first and second substrates which reflect light which is incident at an angle larger than a given angle of

incidence .theta.c and pass light which is incident at an angle smaller than said given angle of incidence,

said display device further comprising an absorbing element which absorbs light passed by said reflecting means.

18. (Added) A reflective flat-panel display device as claimed in claim 17, wherein the reflecting means comprise an angle-dependent reflector which is situated between the liquid crystalline material and the second substrate.

19. (Added) A reflective flat-panel display device as claimed in claim 18, wherein the reflector comprises a stack of dielectric layers.

20. (Added) A reflective flat-panel display device as claimed in claim 17, wherein the reflecting means comprise an angle-dependent diffusor.

REMARKS

Support for the added claims is found as indicated in the copy of the added claims below wherein the information in {} indicates where support for the added claims can be found in the specification.

17. A reflective display device {10} comprising:

a light incident side {substrate 20} and an opposite side, {substrate 22} the display device comprising a diffusing liquid crystalline material {24},

a first substrate on the light incident side and a second substrate on the opposite side enclosing the liquid crystalline material {substrate 20 and substrate 22 enclose liquid crystal material 24}, and

reflecting means between said first and second substrates {28} which reflect light which is incident at an angle larger than a given angle of

incidence .theta.c {total internal reflection} and pass light which is incident at an angle smaller than said given angle of incidence {no internal reflection} {Fig. 4, specification page 9, lines 1-21},

said display device further comprising an absorbing element {60} which absorbs light passed by said reflecting means.

18. {56} A reflective flat-panel display device as claimed in claim 17, wherein the reflecting means comprise an angle-dependent reflector {Fig. 4, specification, lines 1-21} which is situated between the liquid crystalline {24} material and the second substrate {22} {Fig. 3}.

19. A reflective flat-panel display device as claimed in claim 18, wherein the reflector comprises a stack of dielectric layers {54, 56, 58}.

20. A reflective flat-panel display device as claimed in claim 17, wherein the reflecting means comprise an angle-dependent diffusor {56}.

Applicants claim 17-20 are substantial identical to claims 1-3, and 7, respectfully, of U.S. 5,929,956.

Respectfully submitted,

By:

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ENHANCED LIGHT-SCATTERING DISPLAY

DESCRIPTION

Field of the Invention

The present invention relates to a reflective display and in particular to a means of increasing the light reflected by a reflective display without introducing parallax between the primary and reflected images.

Background of the Invention

Liquid crystal displays which switch between a transparent (black) and a light scattering (white) state have insufficient back scattering efficiency to achieve adequate reflectivity in the scattering state. This is because the liquid crystal structures which scatter light do so predominantly in the forward direction, whereas efficient display operation requires light to be back scattered.

Two approaches are known in the prior art to increase the fraction of light back scattered towards the observer. One of these approaches is to increase the thickness of the liquid crystal layer. This approach however results in unacceptably thick liquid crystal layers (the thickness of which approaches the pixel dimension), which have extremely high switching voltages, yet still exhibit inadequate back scattering efficiency.

Another approach employed in the prior art to increase the fraction of light scattered back towards the observer is to utilize a prism sheet, i.e., a selectively reflective material, external to the display cell. The external prism sheet is designed to reflect none of the light transmitted by the liquid crystal layer in its transparent state. Instead, it reflects a portion of the light scattered by the liquid crystal layer in the forward direction in its scattering state back through the liquid crystal layer, where it is scattered a second time, predominantly back towards the viewer.

This approach is illustrated in Fig. 1. Specifically, Fig. 1 shows a vertical cross-sectional view through a display cell 10 as described in the prior art comprising a first transparent substrate 20, a second transparent substrate 22, a layer of liquid crystals 24 and an external prism film 26. The substrates 20 and 22 are patterned with a transparent electrode material and layers to align the liquid crystal layer. For clarity, those layers are not shown in this figure. An image 30 is created in the liquid crystal layer by the application of an electric field between transparent substrates 20 and 22. Thermal means can also be employed to generate the image. When viewed at normal incidence in the direction of arrow 32, the reflected image 34 of image 30 formed in the external prism is coincident with image 30. However, when the display is viewed at an off-normal angle, such as the direction of arrow 36, reflected image 34 is laterally displaced with respect to image 30 in the

direction of arrow 38 and appears in position 40. Thus, the information presented on the display is destroyed by the reflected image from one pixel being superimposed on the primary image of an adjacent pixel or even on pixels beyond the adjacent pixels.

The latter approach, which is illustrated in Fig. 1, has the disadvantage that the image formed by reflection in the prism film is located a substantial distance behind the plane of the liquid crystal layer. This produces unacceptable parallax between the reflected and the primary images when the display is viewed from a direction which is not normal to the display plane. This is particularly problematic in the case of high density displays in which the pixel pitch is of the order of one magnitude less than the display substrate thickness.

In view of the above-mentioned drawbacks with prior art approaches for increasing the fraction of light being back scattered towards an observer, there is a continued need for developing new and improved reflective display devices which are capable of increasing the light reflected without introducing parallax between the primary and reflected images.

Summary of the Invention

The present invention provides a means by which the properties of an external prism film, which relies on refraction and total internal reflection at solid-air

interfaces, is produced in a solid state structure on the surface of the rear pixel electrode inside the display cell. By employing this means rather than the external means illustrated by Fig. 1, enhanced reflectivity is produced from the scattering state, but the problem of parallax is avoided.

Brief Description of the Drawings

Fig. 1 is a vertical cross-sectional view of a display cell 10 as described in the prior art wherein external prism 26 is employed.

Fig. 2 is a vertical cross-sectional view of a display cell 10 which is prepared in accordance with the present invention, i.e. selectively reflector layer 28 is formed on the inside of the cell.

Fig. 3 is a more detailed cross-sectional view of the display cell illustrated in Fig. 2.

Fig. 4 shows details of the structure of the prism layer, in particular of the refractive indices of layers 54, 56 and 58 and the pitch angle (theta) of the prism layer used in Fig. 2.

Fig. 5 shows a perspective view of prism layer 56, low refractive index layer 58 and the light absorbing layer 60. In this example, the prism layer 56 is in the form of triangular section ridges.

Fig. 6 shows a view similar to Fig. 5, but in this case prism layer 56 is in the form of a close packed rectilinear array of square pyramids.

Fig. 7 shows another embodiment of the present invention in which light absorbing layer 60 acts also as the lower display electrode.

Fig. 8 shows yet another embodiment of the present invention in which the rear display electrode is formed of transparent conducting material 62 deposited on to light absorbing layer 60.

Detailed Description of the Invention

The present invention which provides a means for increasing the light reflected by a reflective display without introducing parallax between the primary and reflected images will now be described in greater detail by referring to the drawings that accompany this application. It should be noted that like and corresponding elements or components of the drawings are described by like reference numerals.

As stated briefly above, the performance of reflective displays which rely on back scattering incident light to achieve a white state is limited by the back scattering efficiency of the display transducer. Often the transducer will be a liquid crystal such as a reverse-mode polymer stabilized cholesteric structure (RM-PSCT)

or a polymer dispersed liquid crystal (PDLC), but, while these are used as examples, the present invention applies to any reflective display which can be switched between a transparent and a scattering state. The back scattering efficiency of RM-PSCT or any other scattering effect display can be improved by placing a structure behind the liquid crystal layer which transmits light refracted through the display in its transparent state, for which the maximum angle of propagation is the critical angle, $\varnothing_c$, but reflects light propagating through the display at angles greater than the critical angle. This effect is described in A. Kanemoto, et al., Conference Record of the International Display Research Conference, 183, (1994).

In a typical light scattering liquid crystal, only a minor fraction of the light is back scattered and the majority is forward scattered. A portion of the forward scattered light will propagate at angles greater than the critical angle and it is this light which the selective reflector reflects and redirects back through the liquid crystal layer. If, the selective reflector is positioned outside the display cell, the reflecting surface of the prism film is separated from the plane of the liquid crystal layer by the sum of the thickness of the cell glass and the prism film, or approximately 1.5-2 mm. Consequently considerable parallax is observed, as shown in Fig. 1, making the prior art approach unsuitable for high pixel density displays.

The present invention, on the other hand, relates to the formation of a structure with the required properties on the surface of the pixel electrode, avoiding the parallax problem. That is, the required properties are located inside the display cell itself, not outside as is illustrated in Fig. 1.

Reference in this regard is made to Fig. 2 which shows a cross-sectional view of a cell constructed in accordance with the present invention. As in Fig. 1, the cell of the present invention comprises a first transparent substrate 20, a second transparent substrate 22 and a liquid crystal layer 24 positioned between the first and second transparent substrates. A selectively reflector layer 28 is formed on the inside surface of second transparent substrate 22. Thus, unlike prior art reflective displays wherein the reflective element is located outside the display, in the present invention the reflective element is located within the display itself. The selectively reflector layer has a thickness of from about 1 μm or above. More preferably, the thickness of the selectively reflective layer is from about 1 to about 4 μm.

An image 30 is formed in liquid crystal layer 24 and its reflected image 42 formed in selectively reflector layer 28 is located in a plane only about 1.5 to about 4 μm behind the plane of the liquid crystal layer. No significant lateral displacement of reflected image 42 and image 30 occurs when the display is viewed in the

direction of arrow 36, the parallax between reflected image 42 and image 30 is so small that only a minor displacement of the reflected image occurs to position 44. Thus, the reflected image is not superimposed onto the primary image of the adjacent pixel and displayed information is not lost.

Fig. 3 shows a more detailed cross-sectional view of the cell of Fig. 2 exemplifying a preferred embodiment of the present invention. Specifically, the cell of Fig. 3 comprising a first substrate 20 coated on its inside surface with a transparent electrode 46 and a liquid crystal alignment layer 48. The second substrate 22 is coated with a light absorbing layer 60, a transparent layer 58 of low refractive index, a prism layer 56 of high refractive index, a planarizing layer 54, a transparent electrode 52 and a liquid crystal alignment layer 50. The two substrates contain a layer of liquid crystals 24.

Fig. 4 represents a simplified cross-sectional view through liquid crystal layer 24, low index planarizing layer 54, prism layer 56, low index layer 58 and light absorbing layer 60. For the purpose of clarity in this figure, alignment layer 50 and transparent electrode 52 have been omitted. In addition, it has been assumed that the refractive index n_1 of liquid crystal layer 24 is equal to that of low index planarizing layer 54.

A critical feature of the present invention is that the pitch angle, $\varnothing$, of the prism layer is adjusted so that light propagating through the display at an angle $\leq\varnothing_{c1}$, such that rays 70 and 72, will be incident on the interface between layers 56 and 58 at angles less than the critical angle, $\varnothing_{c2}$, and will be transmitted through low index layer 58 and will be absorbed by light absorbing layer 60. Thus, light not scattered by the liquid crystal layer will be absorbed. Light which is scattered at angles $>\varnothing_{c1}$, such as the ray emanating from position 74, will be totally internally reflected at the interface between layers 56 and 58 back through the liquid crystal layer where it will be scattered a second time, at point 76 predominantly towards the viewer. The optimum value of $\varnothing$ will be a function of $_{n1}$, $_{n2}$, and $_{n3}$.

Under some conditions of display use, it may be preferred that the selectively reflective layer is designed to become reflective at angles less than $\varnothing_{c1}$. In this case the usable viewing angle will be reduced, but the degree of enhancement of back scatter will be increased.

The distance between successive ridges of the prism layer should be substantially less than the pixel dimension so that the action of the selective reflector produces a uniform enhancement of the back scatter efficiency. However, it should not be so small that diffraction effects occur. In practice, a pitch of about 1.5 to about 5 μm is satisfactory.

Processes by which the structure of the present invention can be made will now be described. Referring first to Fig. 3, a layer of light absorbing material 60 is deposited on to the rear of substrate 22. The light absorbing material can be made of any light absorbing polymeric material such as a dyed or pigmented polyamide, a composite metal/oxide or cermet material. In this particular embodiment, light absorbing layer 60 can be a conductor or an insulator. If conducting, layer 60 must be appropriately patterned to avoid pixel-pixel short circuits. If insulating, light absorbing layer 60 can be left as a continuous sheet. A layer 58 of a low refractive index transparent material is then deposited on to light absorbing material 60. Layer 58 should be of as low a refractive index as possible and its properties must be compatible with the processing requirements of the layers subsequently deposited. Typically, a refractive index, n, of from about 1.35 to about 1.45 will be sufficiently low. A fluorinated material such as Teflon PFA (n=1.35) is an example of a suitable material.

High index prism layer 56 is then deposited. Ideally, this layer comprises a composite of silicon and zirconium oxides. Such a layer has a high refractive index (n≈2.1) and is amorphous, the latter property being required for the patterning process. The layer can be deposited by sputtering or any other known deposition process. An Al etch mask is then deposited on to layer 56 and patterned either with an array of slits to produce the ridged pattern shown in Fig. 5 or with an array of square

apertures to produce the rectilinear array of pyramids depicted in Fig. 6. Layer 56 is then reactively sputter etched in an oxygen atmosphere. During this process, the Al etch mask is gradually eroded, enlarging the apertures in it. The process may be optimized by adjusting the etch mask thickness and the initial dimensions of the apertures so that high index prism layer 56 becomes etched through at the instant the etch mask is completely removed. This produces sharp ridges and apexes. The angle of the ridges and the prism angle ∅, as depicted in Fig. 4, are adjusted by varying the etch process conditions to optimize the differential etch rate of the prism layer and the etch mask. In practice, values of ∅ between 35° and 50° can be obtained.

The high index prism layer 56 is then spun coated with a planarizing layer 54 of a low index material which can be, but is not necessarily, the same as layer 58. A layer of transparent electrode material 52 is then deposited on to planarizing layer 54 and an aligning layer 50 is deposited on to layer the transparent electrode.

The above process serves to illustrate one method by which the selectively reflection layer can be made. The structures depicted in Fig. 7 and 8 can be made by a similar process, either by eliminating layer 52 and choosing a conducting layer 60 (Fig. 7) or by depositing and patterning a transparent conducting layer 62 between layers 58 and 60 (Fig. 8).

The above process is however not optimized for volume manufacture and alternative processes exits which may be better optimized for manufacture. An alternative method is to mold the required ridge or pyramid pattern. A mold can be made in a material which is subsequently removed during processing or the pattern can be molded directly in a material which can be spun coated and then converted by a firing process to a high index layer which retains the required surface geometry. Sol gels of ZrO_2/SiO_2 mixtures would be suitable for this purpose. Because of the processing temperatures involved (>250°-300°C), it is necessary to make layers 58 or 60 as an adhesive layer and then remove the sacrificial substrate. The above described process can easily be used in volume manufacture. Other alternative processes are also known in the art and thus could be used for volume expansion.

While the invention has been particularly shown and described with respect to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the present invention.

CLAIMS

Having thus described our invention, what we claim as new, and desire to secure the letters Patent is:

1. A display device comprising a structured solid state selectively reflective layer formed inside a display cell, wherein said structured solid state selectively reflective layer transmits light that is not scattered by the display device and reflects a portion of light that is scattered in a forward direction by the display device back towards a viewer.

2. The display device of Claim 1 wherein the display device contains liquid crystals.

3. The display device of Claim 2 wherein the liquid crystals are polymer stabilized cholesteric liquid crystals.

4. The display device of Claim 2 wherein the liquid crystals are polymer dispersed liquid crystals.

5. The display device of Claim 2 wherein the liquid crystals are surface stabilized cholesteric liquid crystals.

6. The display device of Claim 2 wherein the liquid crystals can be switched by means of an electric field from a transparent to a scattering state.

7. The display device of Claim 2 wherein the liquid crystals can be switched by thermal means from a transparent to a scattering state.

8. The display device of Claim 1 wherein the selectively reflective layer has a thickness of a least about 1 μm.

9. The display device of Claim 1 wherein the selectively reflective layer is a high or low refractive index material.

10. The display device of Claim 9 wherein the high refractive index material is a mixed oxide amorphous material.

11. The display device of Claim 9 wherein the low refractive index material is a fluorinated polymeric material.

12. The display device of Claim 1 wherein the selectively reflective layer is formed as a series of ridges substantially triangular in cross-section.

13. The display device of Claim 1 wherein the selectively reflective layer is formed as a close packed rectilinear array of square pyramids.

14. The display device of Claim 1 wherein a transparent electrode layer is formed on top of the selectively reflective layer.

15. The display device of Claim 1 wherein a transparent electrode layer is formed between the selectively reflective layer and a light absorbing layer.

16. The display device of Claim 1 wherein the selectively reflective layer is designed to become reflective at angles less than a predetermined critical angle for propagation of light therethrough.

ENHANCED LIGHT-SCATTERING DISPLAY

Abstract of the Disclosure

A display device having a selectively reflective layer inside the display cell is described. By incorporating the selectively reflective layer inside the display cell itself, enhanced reflectivity is produced from the scattering state, but the problem of parallax is substantially avoided.

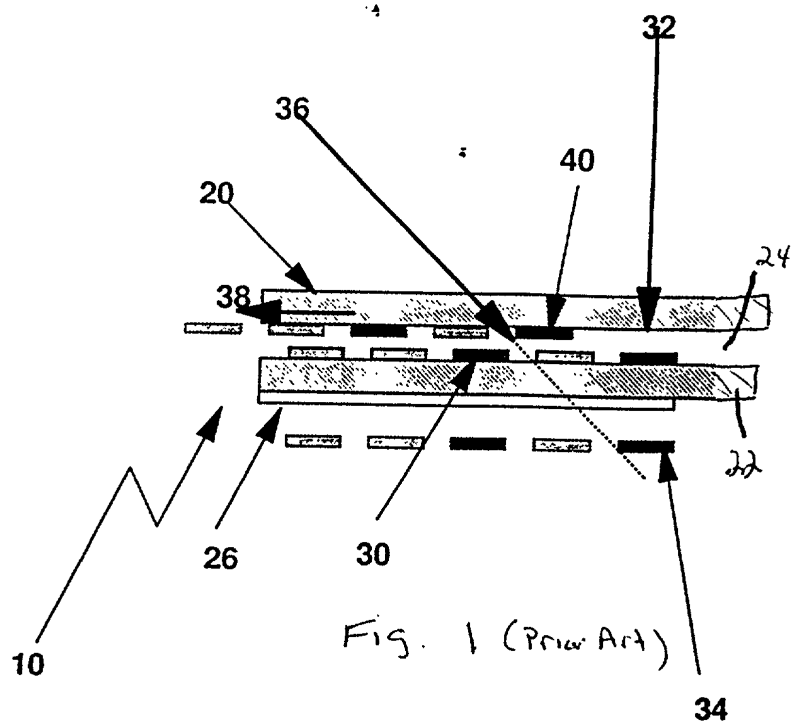

Fig. 1 (Prior Art)

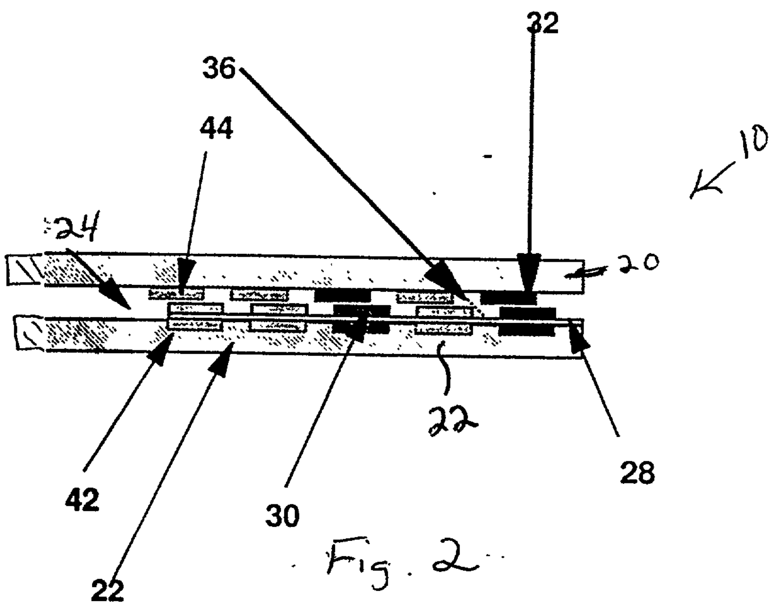

Fig. 2

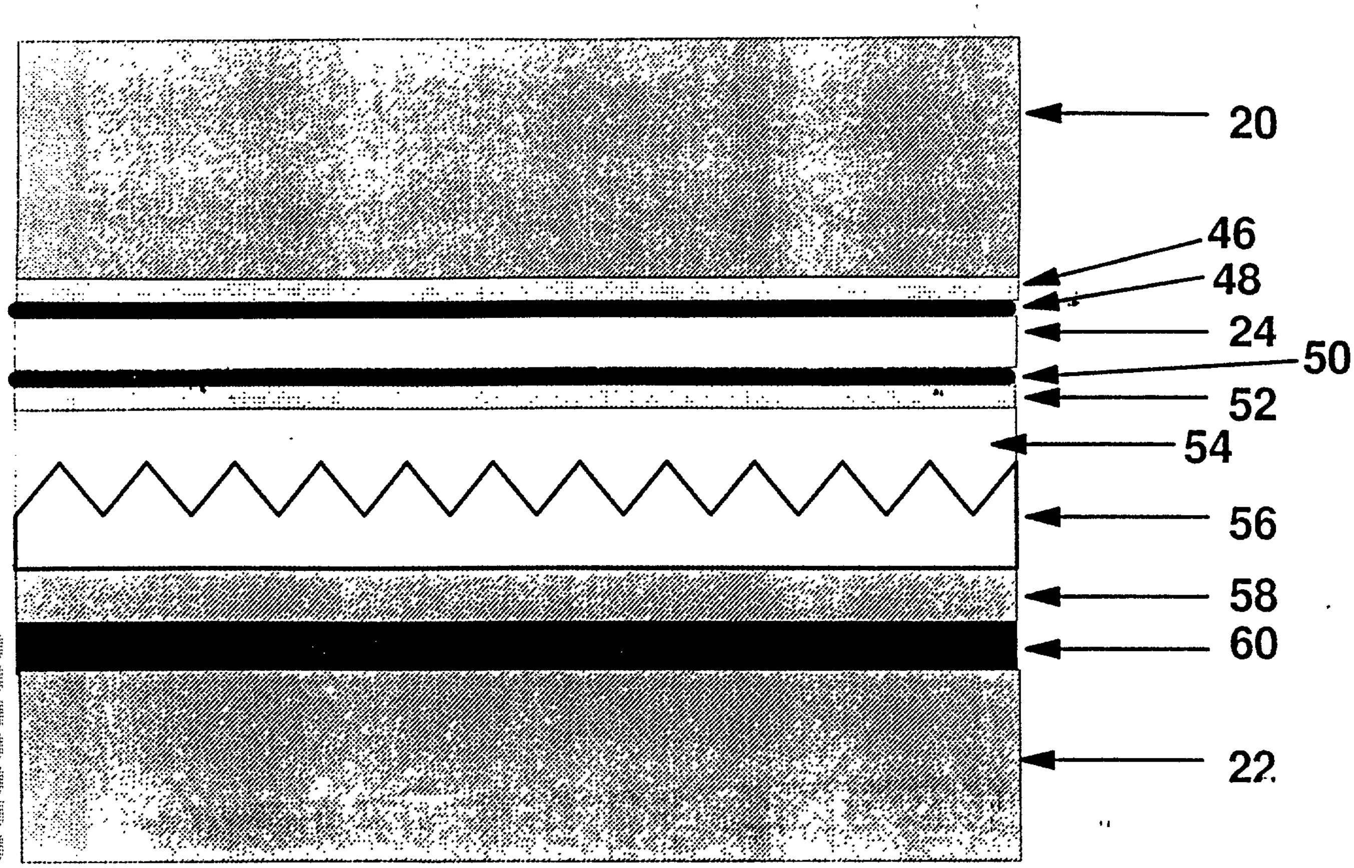

Fig.3

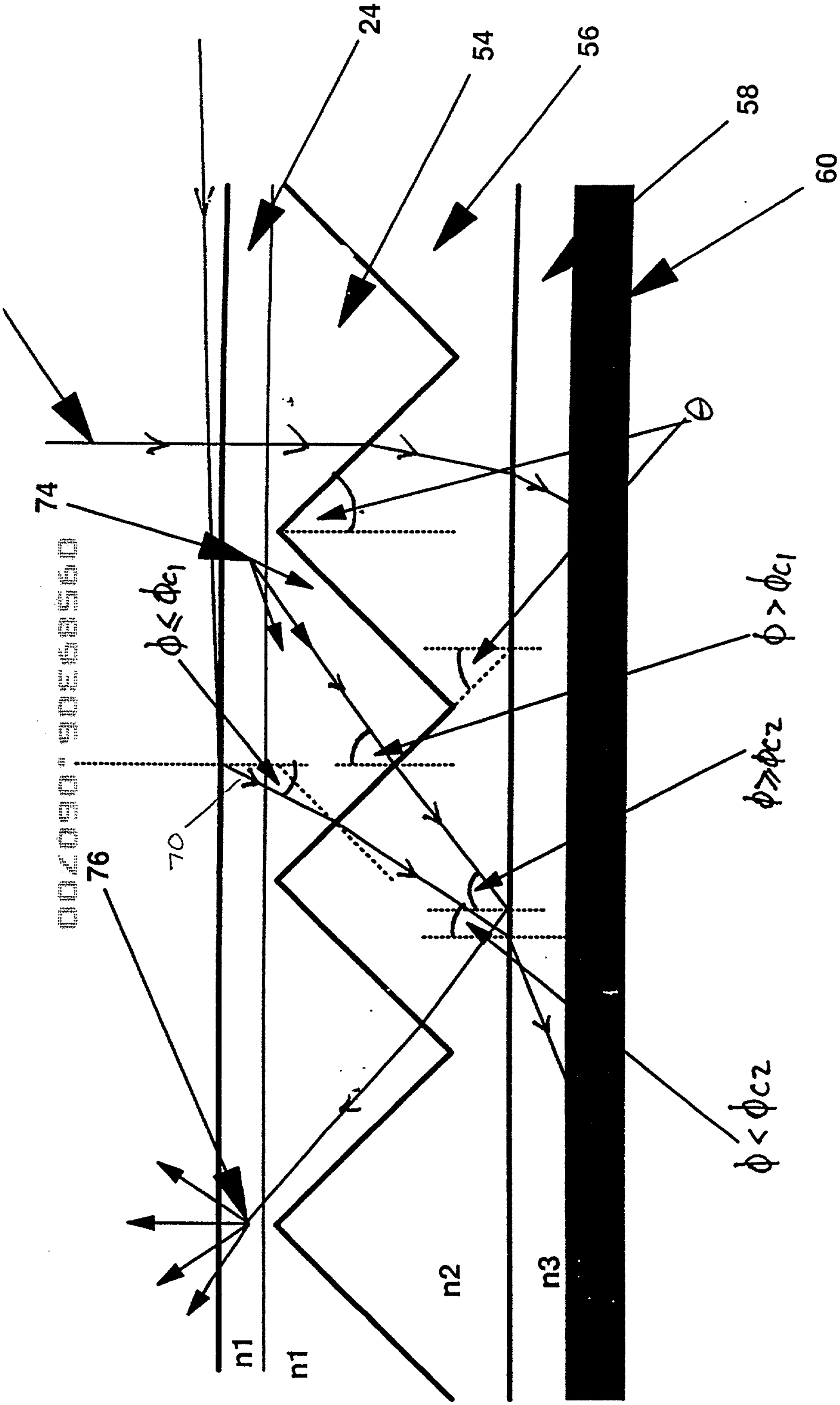

Fig. 4

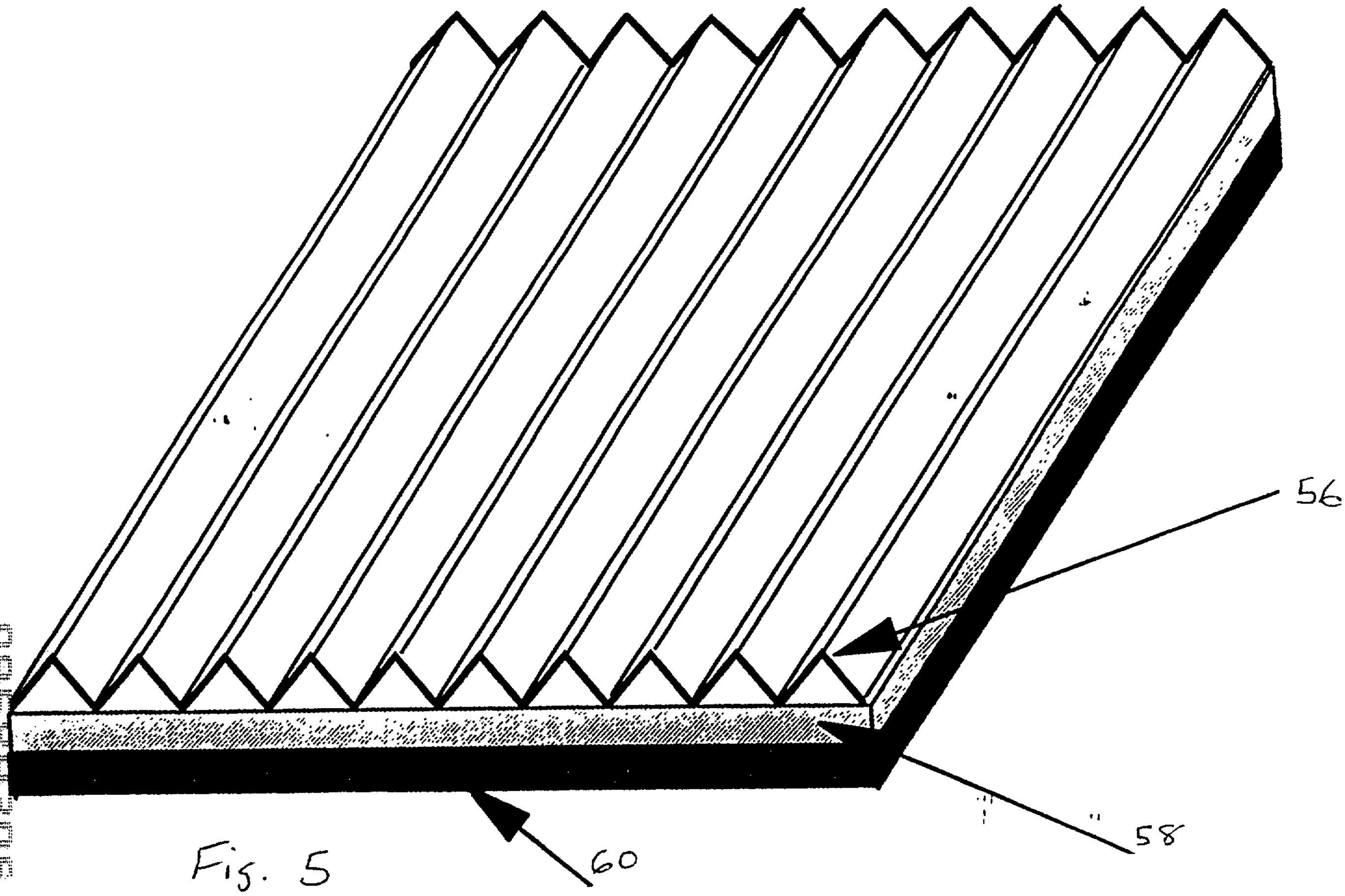

Fig. 5

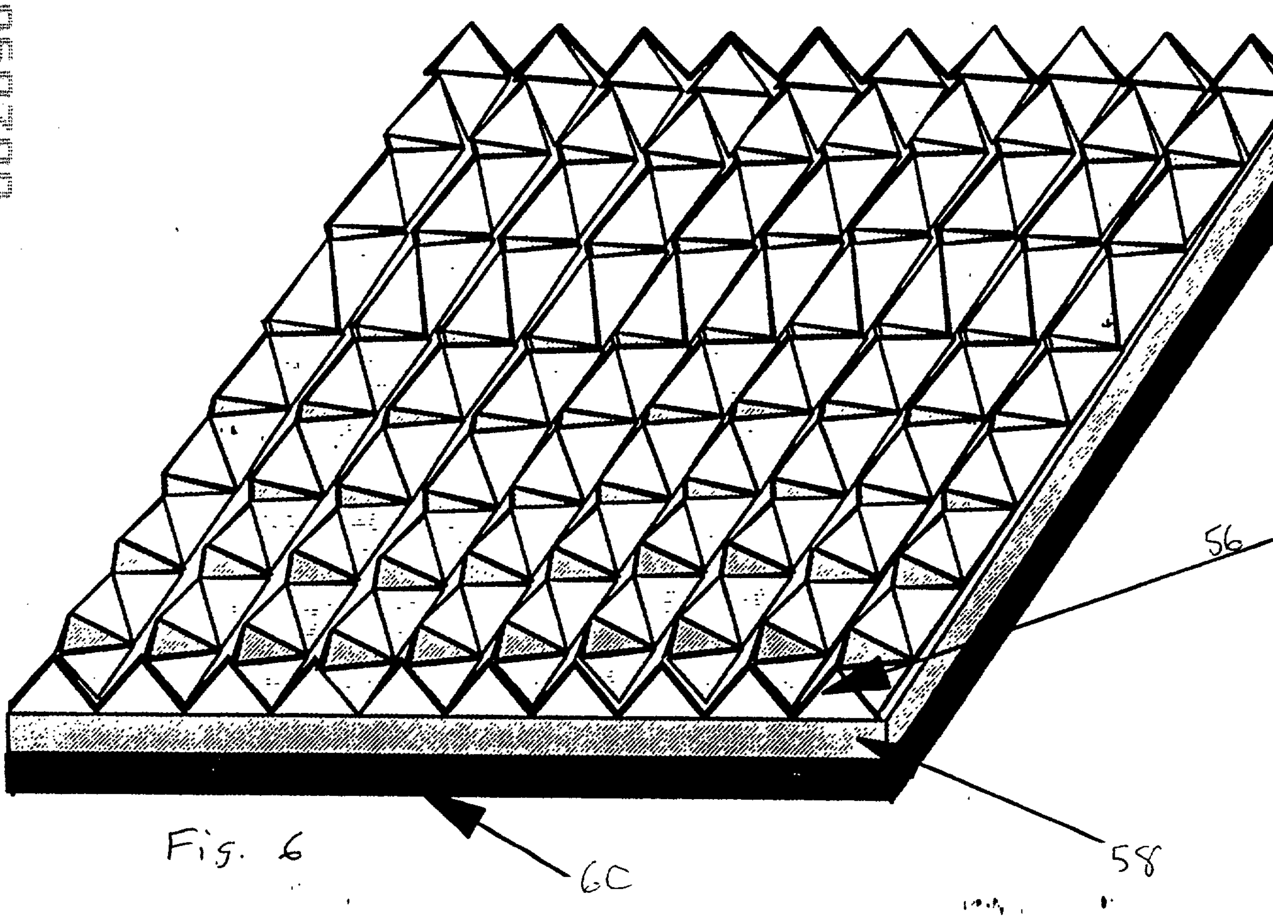

Fig. 6

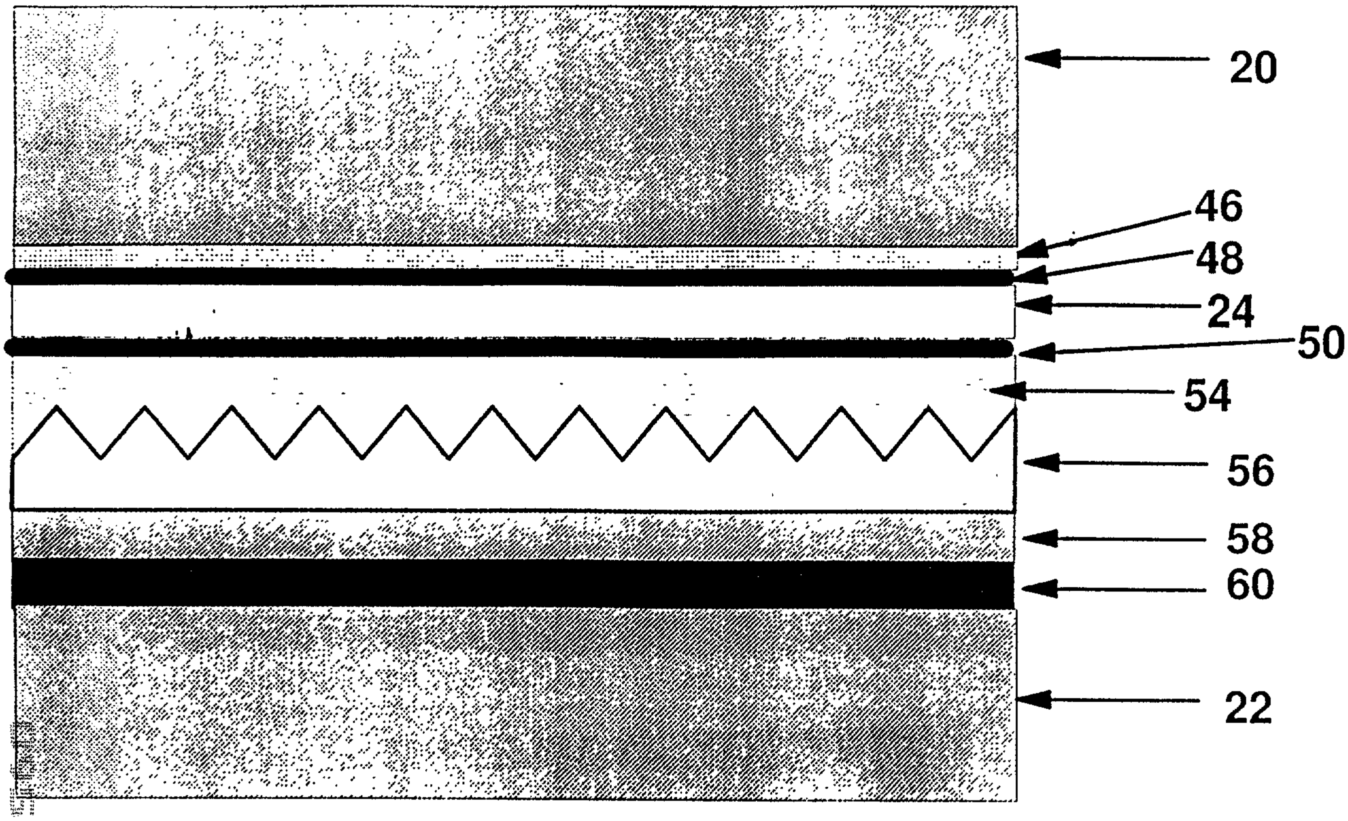

Fig. 7

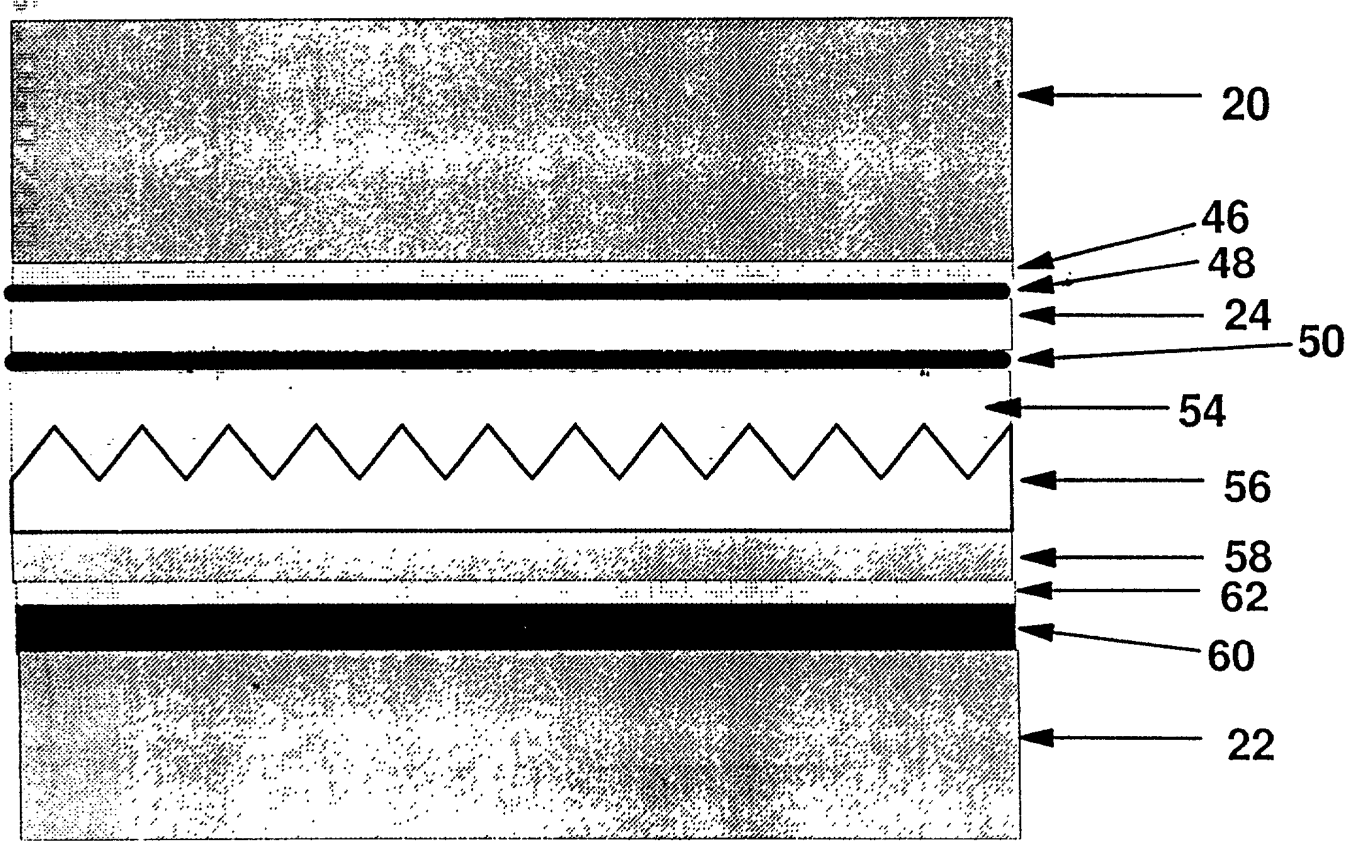

Fig 8

SSM&P Docket No.: 11577
IBM Docket No.: YO998-267

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ENHANCED LIGHT-SCATTERING DISPLAY

the specification of which (check one)

X is attached hereto.

___ was filed on ________ as United States Application Number ________

or PCT International Application Number ________

and was amended on ________ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application, having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

			Priority Claimed
(Number)	(Country)	(Day/Month/Year Filed)	___ Yes ___ No
(Number)	(Country)	(Day/Month/Year Filed)	___ Yes ___ No
(Number)	(Country)	(Day/Month/Year Filed)	___ Yes ___ No

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

I hereby claim the benefit under 35 U.S.C. §120 of any United States Application(s), or §365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States, or PCT International application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose information material to the patentability of this application as defined in 37 CFR §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number).

Manny W. Schecter (Reg. 31,722), Terry J. Ilardi (Reg. 29,936), Christopher A. Hughes (Reg. 26,914), Edward A. Pennington (Reg. 32,588), John E. Hoel (Reg. 26,279), Joseph C. Redmond, Jr. (Reg. 18,753), Douglas W. Cameron (Reg. No. 31,596), Kevin M. Jordan (Reg. No. 40,277), Stephen C. Kaufman (Reg. No. 29,551), Daniel P. Morris (Reg. No. 32,053), Louis J. Percello (Reg. No. 33,206), Jay P. Sbrollini (Reg. No. 36,266), David M. Shofi (Reg. No. 39,835), Robert M. Trepp (Reg. No. 25,933) and Louis P. Herzberg (Reg. No. 41,500).

Send Correspondence to: Richard L. Catania, Scully, Scott, Murphy & Presser
400 Garden City Plaza, Garden City, New York 11530

Direct Telephone Calls to: (name and telephone number) Richard L. Catania, (516) 742-4343

Anthony Cyril Lowe
Full name of sole or first inventor

X Anthony C Lowe
Inventor's Signature

X 10 Sept 1998
Date

Orchard Rise, Braishfield Road, Braishfield Hampshire SO51 OPO, United Kingdom
Residence

Great Britain
Citizenship

Same as above
Post Office Address